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OPTICAL IONOSPHERE RESEARCH

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This technical report has been reviewed and is approved for publication.

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Provide optical imaging of the ionosphere and scintillation measurement support to AFRL. Keo provided technical expertise in these areas by maintaining, upgrading and fielding various AFRL owned imagers built by Keo and writing acquisition and networking software. As a result of the contract being descoped, only a two-page summary is required.

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1. Introduction:

The main tasks on this contract were to provide optical imaging of the ionosphere and scintillation measurement support to AFRL. Keo provided technical expertise in these areas by maintaining, upgrading and fielding various AFRL owned imagers built by Keo and writing acquisition and networking software. As a result of Contract descoping, only a 2-page Final report is required.

2. Hardware:

The primary task of maintaining and upgrading the existing suite of optical imaging systems culminated in standardizing a common interface to a host computer for the lab's three high end all-sky imagers: HAARP, MIP, and ASIP-II. As expensive data acquisition components, like the frame grabber boards, became obsolete and unserviceable, we chose to design an interface that would outlast the imager itself. The widely adopted parallel port of PC's provides adequate data transfer rates of up to 1.2 Megabytes per second in EPP mode. This also gave us the option of using laptops for campaigns and reducing shipping costs. An external parallel port interface box was designed and built to facilitate the transfer of CCD pixels between the imager and the host computer. Two other 35mm film reel based all-sky cameras were upgraded with CCD cameras supporting NTSC standard video outputs.

General maintenance and support on the optical and filter wheel subsystems were carried out throughout the contract period as needed. They included procuring new and replacement filters and image intensifiers. Accordingly, the optical subsystem often had to be recalibrated.

The data acquisition computers for the imagers have been upgraded as new technologies driven by the computer industry have become more affordable. They include CDR's (Recordable Compact Disc's) which can hold about 650 Megabytes of data at a cost of less than $1 per CD. They have replaced our previous image storage media, the MO (Magneto Optical) disk of equal capacity that are over $100 per cartridge. Memory IC's, network cards, modems, larger hard disk drives, and video display peripherals were also procured as part of the upgrade tasks.

Several network capable PC-systems were configured and installed to support AFRL's ionospheric scintillation monitoring program. Keo developed and implemented the dual-PC acquisition and server system for multi-instrument remote access of data. Primarily used for L-Band, UHF, and specifically, GPS based scintillation, most of hardware were configured from AFRL furnished equipment. Peripherals, often network related such as modem and network cards, were purchased to make them fully functional in the field.

3. Software:

The acquisition software for our optical imagers underwent a dramatic design change from a Microsoft based operating system (Windows 3.11) to open source Linux (a UNIX derivative) operating system. This was primarily driven by a combination of using software drivers for obsolete frame grabber hardware and the desire to adopt the philosophy of using a stable operating system that supports networking. Linux has the additional benefit of being open source - free or shareware software. Most software upgrades, whether it's an application, a tool, or the operating system itself, is free and readily available. We developed the acquisition software using C, and display images in real time using X-windows. Two major features implemented into our software system during this contract are the ability to truly run unattended with automatic exposure and gain control and the ability to run remotely over the network. Both of these features were successfully demonstrated in the field with real data.

Keo was instrumental at providing networking and data automation software for the monitoring stations of AFRL's SCINDA (Scintillation Decision Aid) network. Linux was also used on the data server computer to augment networked data transfers. GPS-based scintillation receivers, such as the Novatel units, were integrated into the field instrumentation. Scripts were written to automate the transfer of real-time scintillation data back to AFRL at fixed intervals. Keo also administered network security requirements for certain field computers as well as three SGI UNIX workstations at the lab.

4. Field Support and Data Analysis:

Keo travelled to several locations in both the Arctic and South America in support of campaigns in which AFRL participated. Keo was responsible for coordinating shipping logistics of and the operation of optical all-sky imagers. High latitude ionospheric observations of aurora and plasma drift measurements were conducted in Sondrestrom and Qaanaaq, Greenland, Svalbard, Norway, and at AFRL's HAARP site in Gakona, Alaska. Equatorial airglow measurements were conducted in northern Chile to measure the onset and evolution of the Spread-F phenomena. Keo has been an active participant in AFRL's HAARP program by providing optical diagnostic instrumentation, primarily for support of heater-induced airglow measurements. Other optical field support involved real-time measurements of sprite phenomena in Colorado using a Keo built image intensified B&W S-VHS video camera.

Data processing on collected optical and GPS-based scintillation data were carried out as necessary for analysis and publication. IDL for UNIX was utilized to generate static and animated frames of optical data. GIF and MPEG multimedia data files and archived raw data on CD's were created for distribution.